

Amendments to the Claims

This listing of claims will replace all prior versions, and listings, of claims, in the application. Amendments are indicated by underscoring text to be added, and by ~~striking through~~, or ~~[[double bracketing]]~~ text to be deleted:

Claim 1 (currently amended): A method of making a carbon fiber reinforced ~~/silicon~~ composite body, comprising:

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- (a) providing a reinforcement material comprising a plurality of carbon fibers;
 - (b) organizing said reinforcement material to a desired bulk shape;
 - (c) applying at least one coating ~~one or more coatings~~ to said fibers, said at least one coating ~~coatings~~ intended to protect said fibers from chemical reaction with molten silicon, and intended to permit no more than a weak mechanical bond to the matrix;
 - (d) supplying no more than about 10 percent by weight carbon to the arranged fibers to make a preform;
 - (e) contacting a source of molten ~~silicon~~ metal comprising silicon to said preform;
 - (f) infiltrating molten metal ~~silicon~~ from said source into said preform, thereby forming a composite material comprising said carbon fibers dispersed in a matrix comprising silicon carbide and said molten ~~silicon~~ metal; and
 - (g) solidifying said molten ~~silicon~~ metal in said composite material, thereby forming a composite body comprising at least about 15 percent by volume of said metal and no more than about 25 percent by volume of said silicon carbide.

Claim 2 (currently amended): A method for making a carbon fiber reinforced ~~/silicon/silicon carbide~~ composite body, comprising:

- (a) providing a porous zero-stage carbon/carbon composite preform comprising carbon fibers dispersed in a matrix consisting predominantly of carbon;
- (b) contacting said composite preform to a source of molten infiltrant metal comprising silicon ~~metal~~;
- (c) ~~[[f]]~~ infiltrating silicon from said source of molten infiltrant metal into said preform, thereby forming a composite material comprising said carbon fibers dispersed in a

matrix comprising ~~said silicon~~ molten metal comprising silicon and at least some silicon carbide formed in-situ; and

(d) ~~[[g]]~~ solidifying said ~~silicon~~ metal in said composite material, thereby forming a composite body comprising at least about 20 percent by volume of said metal and no more than about 40 percent by volume of said silicon carbide.

Claim 3 (currently amended): A method for making a carbon fiber reinforced ~~/silicon~~ composite body, comprising:

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- (a) providing a reinforcement material comprising a plurality of carbon fibers;
 - (b) contacting a silicon-containing polymeric resin to at least said carbon fibers;
 - (c) pyrolyzing the preceramic polymer to leave a silicon-containing ceramic coating on the carbon fibers, such as silicon carbide ~~[[SiC]]~~, thereby forming a preform;
 - (d) supplying the preform with a source of reactable carbon;
 - (e) pyrolyzing the reactable carbon source, leaving the preform with about 1 to about 10 percent by volume of reactable carbon; and
 - (f) reactively infiltrating the preform with an infiltrant metal comprising silicon ~~the silicon or silicon alloy~~ to yield a composite body comprising carbon fibers having a silicon carbide ~~[[SiC]]~~ coating, and a matrix comprising residual infiltrant metal Si (or alloy) and at least some in-situ silicon carbide ~~[[SiC]]~~; and
 - (g) solidifying said residual infiltrant metal ~~silicon metal~~ in said composite material, thereby forming a composite body comprising at least about 15 percent by volume of said residual infiltrant metal and no more than about 30 percent by volume of said silicon carbide.

Claim 4 (currently amended): A carbon fiber reinforced ~~/silicon/silicon carbide~~ composite body, comprising:

- (a) a plurality of carbon fibers;
- (b) a matrix ~~[[phase]]~~ comprising silicon carbide and an infiltrant metal comprising silicon at least about 15 percent by volume of silicon and not more than about 40 volume percent silicon carbide; and
- (c) a zone of carbon disposed between said fibers and said matrix; and

(d) wherein said composite body comprises at least about 20 percent by volume of said infiltrant metal and not more than about 40 percent by volume of said silicon carbide.

Claim 5 (currently amended): A carbon fiber reinforced ~~/silicon~~ composite body, comprising:

(a) a matrix ~~[[phase]]~~ comprising silicon carbide and at least one metal comprising silicon ~~at least about 30 percent by volume of silicon and not more than about 10 volume percent silicon carbide;~~

(b) a reinforcement ~~[[phase]]~~ comprising a plurality of carbon fibers; and

(c) at least one coating ~~one or more coatings~~ disposed between said fibers and said matrix, said at least one coating ~~coatings~~ serving functions comprising chemical protection of said carbon fibers at least from said silicon, and providing a toughening mechanism for said composite body; and

(d) wherein said composite body comprises at least about 20 percent by volume of said metal and not more than about 40 percent by volume of said silicon carbide.

Claims 6 and 7 (canceled).

Claim 8 (currently amended): The composite body of claim 5, wherein said at least one ~~protective~~ coating comprises silicon carbide.

Claim 9 (currently amended): The composite body of claim 5, wherein said at least one ~~debond~~ coating comprises boron nitride.

Claim 10 (currently amended): The composite body of claim 5, wherein said carbon fibers make up at least about 10 % ~~to about 70%~~ by volume of said composite body.

Claim 11 (currently amended): The composite body of claim 5, comprising at least about 45% by volume of said metal ~~silicon~~ phase.

Claim 12 (currently amended): The composite body of claim 5, wherein said silicon carbide [[SiC]] of said matrix [[phase]] comprises less than about 10% of said composite body.

Claim 13 (canceled).

Claim 14 (original): The composite body of claim 13, wherein said woven arrangement comprises a weave selected from a plain weave and a harness satin weave.

Claim 15 (original): The composite body of claim 5, further comprising a CTE less than about +2 ppm/K.

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Claim 16 (original): The composite body of claim 5, further possessing an absolute value of CTE less than about 1 ppm/K.

Claim 17 (original): The method of claim 2, wherein said carbon of said matrix derives from at least one source selected from the group consisting of pitch, phenolic resin, furfuryl alcohol and epoxy resin.

Claim 18 (original): The method of claim 2, wherein not reacting all of said matrix carbon is accomplished by maintaining a temperature of infiltration below about 1600C.

Claim 19 (original): The method of claim 2, wherein said not reacting all of said matrix carbon is accomplished by applying said matrix carbon in a thickness greater than about 2 microns.

Claim 20 (original): The method of claim 2, wherein said not reacting all of said matrix carbon is accomplished by providing said carbon from a precursor source having a high char yield.

Claim 21 (original): The composite body of claim 5, wherein said fibers have an isotropic or quasi-isotropic arrangement.

Claim 22 (original): The composite body of claim 5, wherein said fibers are not arranged quasi-isotropically.

Claim 23 (original): The composite body of claim 5, wherein said carbon fibers possess a negative CTE in the axial direction.

Claim 24 (original): The composite body of claim 5, wherein said carbon fibers do not possess a negative CTE.

Claim 25 (original): The composite body of claim 5, wherein said carbon fibers possess an elastic modulus of at least about 200 GPa in the axial direction.

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Claim 26 (original): The composite body of claim 5, wherein said reinforcement phase is present as at least one sheet or layer, and said thermal expansion coefficient is quasi-isotropic within the plane of said sheet or layer.

Claim 27 (original): The composite body of claim 5, wherein said reinforcement phase is present as at least one sheet or layer comprising said fibers randomly arranged within the plane of said sheet or layer.

Claim 28 (currently amended): The composite body of claim 5, wherein said reinforcement [[phase]] is present as at least one sheet or layer, and said thermal expansion coefficient is quasi-isotropic within the plane of said sheet or layer.

Claim 29 (currently amended): The composite body of claim 5, wherein said reinforcement [[phase]] is present as at least one sheet or layer comprising said fibers randomly arranged within the plane of said sheet or layer.

Claim 30 (original): The composite body of claim 5, wherein said fibers comprise graphite having a negative thermal expansion coefficient in a fiber axis direction.

Claim 31 (currently amended): The composite body of claim 28, wherein said reinforcement [[phase]] comprises a plurality of said layers arranged substantially parallel to one another, each of said layers comprising a plurality of substantially parallel carbon fibers, wherein an absolute value of angle as measured between the longitudinal axes of said carbon fibers in one layer and those in an adjacent layer is selected from the group consisting of 0 degrees, 45 degrees, 60 degrees and 90 degrees.

Claim 32 (original): The method of claim 1, further comprising green machining said preform.

Claim 33 (original): The composite body of claim 4, wherein said carbon fibers are arranged with respect to one another so as to achieve at least a quasi-isotropic CTE in the formed composite body.

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Claim 34 (currently amended): The composite body of claim 5, wherein said matrix [[phase]] comprises at least one metal other than silicon.

Claim 35 (Previously presented): The composite body of claim 33, wherein said at least one metal comprises aluminum.

Claim 36 (currently amended): The composite body of claim 5, wherein said silicon carbide [[SiC]] of said matrix [[phase]] comprises about 1%-5% of said composite body.

Claim 37 (currently amended): A composite material comprising graphite fibers dispersed in a matrix material comprising silicon and silicon carbide by volume at least 50 percent elemental silicon, said graphite fibers possessing a negative CTE at least in the axial direction, said composite material further comprising at least about 50 percent by volume of said silicon and not more than about 20 percent by volume of said silicon carbide.

Claim 38 (Previously presented): The composite material of claim 36, produced by a process comprising:

- (a) coating silicon carbide onto said graphite fibers;
- (b) collecting said fibers as a porous preform;
- (c) introducing a carbonaceous resin to said preform;
- (d) pyrolyzing said resin, thereby adding about 1-10 percent by weight of carbon to said preform;
- (e) contacting a source of silicon or silicon alloy in molten form to said carbon-containing preform;
- (f) infiltrating said molten silicon or silicon alloy into said carbon-containing preform, thereby forming said matrix material; and
- (g) solidifying said silicon or silicon alloy.

Claim 39 (canceled).

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Claim 40 (currently amended): The composite material of claim 37 [[38]], wherein at least some of said silicon carbide is provided on said graphite fibers as a protective coating intended to prevent direct contact of said graphite fibers with said silicon during processing.

Claim 41 (Previously presented): The composite material of claim 37, wherein said fibers are provided as at least one substantially flat ply, and a coefficient of thermal expansion of said composite is quasi-isotropic within the plane of said ply.

Claim 42 (Previously presented): The composite material of claim 37, wherein said fibers are provided in the form of a plurality of stacked plies, and further wherein said fibers are substantially unidirectional within a ply, and further wherein said plies are oriented with respect to one another as to produce a quasi-isotropic coefficient of thermal expansion within the plane of said stacked plies.

Claim 43 (Previously presented): The composite material of claim 41, wherein said quasi-isotropic condition is achieved by orienting said plies at angles of +45 degrees, -45 degrees and 90 degrees with respect to a reference ply.

Claim 44 (Previously presented): The composite material of claim 41, wherein said quasi-isotropic condition is achieved by orienting said plies at angles of +60 degrees and -60 degrees with respect to a reference ply.

Claim 45 (Previously presented): The composite material of claim 37, comprising at least about 30 percent by volume of said fibers.

Claim 46 (currently amended): The ~~metal-matrix~~ composite material of claim 37, further comprising a coefficient of thermal expansion no greater than about 4 ppm/K.

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Claim 47 (currently amended): The ~~metal-matrix~~ composite material of claim 42, wherein an overall CTE of said composite in a quasi-isotropic direction is no greater than about 3 ppm/K.

Claim 48 (New): The composite body of claim 5, wherein said at least one coating comprises elemental carbon.

Claim 49 (New): The composite body of claim 5, wherein said metal consists essentially of said silicon.

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Claim 50 (New): The composite body of claim 5, wherein said silicon is present as an alloy.

Claim 51 (New): The method of claim 1, wherein said fibers make up no more than about 60 percent of a bulk volume of said bulk shape.

Claim 52 (New): The method of claim 2, wherein said fibers make up no more than about 60 percent of a bulk volume of said preform.
